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SPRINGFIELD ARMORY

SPRINGFIELD, MASSACHUSETTS

RESEARCH AND DEVELOPMENT

Report: SA-TR19-1505

Date: 6 April 1961

Report Title: Nondestructive Inspection of Receivers for 7.62mm M14 Rifle by Electromagnetic Methods

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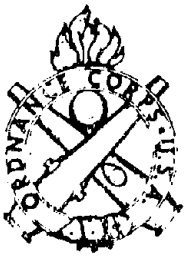

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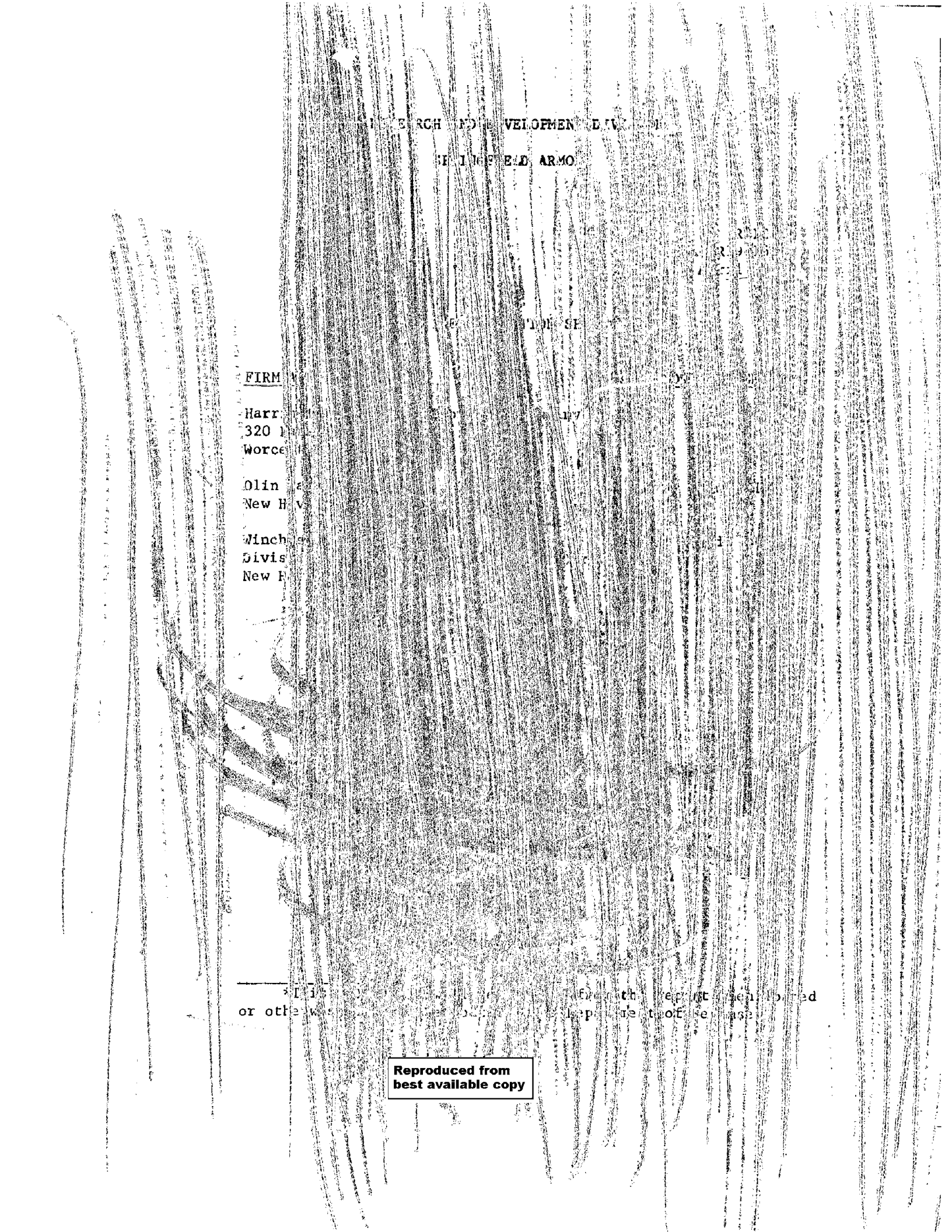
Project Title: Engineering of Application of Nondestructive Methods and Equipment to Small Arms Weapon Items

Ord Project: Industrial Preparedness Measure

Preparing Agency: Springfield Armory, Springfield, Mass.



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NONDESTRUCTIVE INSPECTION OF RECEIVERS FOR 7.62MM M14 RIFLE BY ELECTROMAGNETIC METHODS, by R. D. Korytoski, H. P. Hatch, and E. H. Abbe, Tech Report SA-TR19-1505, 6 Apr 61, 60 pp incl illus, Ord Proj - Industrial Preparedness Measure.

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1. Nondestructive testing
2. Electromagnetic test methods
3. Receiver, M14 7.62mm

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1. Nondestructive testing
2. Electromagnetic test methods
3. Receiver, M14 7.62mm

REPORT
SA-TR19-1505

ABSTRACT

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Springfield Armory, Springfield, Mass.
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1. Nondestuctive testing
2. Electromagnetic test methods
3. Receiver, M14 7.62mm

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LIST OF ILLUSTRATIONS

REPORT
SA-TR19-1505

SUBJECT

Inspection of Receivers for 7.62MM M14 Rifle by Electromagnetic Methods

OBJECT

To develop a nondestructive test method for segregating receivers made from materials other than the specified resulphurized 8620H steel.

SCOPE

The segregation of mixed steels and the heat-treat variations in receivers made from specified resulphurized 8620H material were studied. Electromagnetic tests, distribution studies, spectrographic results, and metallurgical examinations of hardness and microstructure to correlate test results are discussed.

CONCLUSIONS

1. An electromagnetic test method was developed which successfully segregated receivers made from spurious steels. The correlation of the test method with spectrographic results was excellent.

2. Distribution studies of receivers made from specified materials indicated a wide range in readings caused by variations in the heat-treat process.

3. A test instrument range of -40 to +40 was established for acceptance of receivers made from resulphurized 8620H material based on the studies made. Receivers of high nickel alloy material gave a minus off-scale reading; receivers made of 1330 steel gave plus 85 to plus off-scale readings.

4. Electromagnetic test readings, more negative than -40 on receivers made from specified material, can be attributed to:

   a. Generally soft receivers,

   b. Sections locally tempered or annealed,

   c. Receivers tempered or retempered at relatively high temperatures.

5. Electromagnetic test readings, more positive than +40 on receivers made from specified material, can be attributed to generally hard receivers (case and/or core).

RECOMMENDATIONS

1. The developed electromagnetic test method should be employed to segregate receivers made from spurious materials.

2. A program should be undertaken to determine the feasibility of applying the electromagnetic method for in-process inspection of receivers. In-process inspection could monitor heat-treat procedures and insure that receiver specification and heat-treat requirements are being met.

REPORT
GA-TR19-1505

1. SUBJECT

Nondestructive Inspection of Receivers for 7.62MM M14 Rifle by Electromagnetic Methods.

2. INTRODUCTION

A program to develop a nondestructive test method for segregating M14 receivers (component drawing F7790189) manufactured from improper steel began in December 1960. This program was the result of a receiver rupturing at Ft. Benning, Georgia, and a second such rupturing at a contractor's plant following the test firing of one proof round. Chemical analyses revealed that the ruptured receivers were fabricated from 1330 steel. Initial screening investigations uncovered a second mixed steel, an alloy containing approximately 4 per cent nickel. The component specification required fabrication from resulphurized 8620H steel. The brittle behavior of receivers fabricated from 1330 steel necessitated the development of a nondestructive test method for separations and subsequent establishment of a segregation program at contractor plants and designated locations.

Watertown Arsenal personnel assisted in the work of this program; reported efforts were coordinated with them.

3. PROCEDURE

The problem appeared solvable by use of electromagnetic methods. Most of these methods require a complete specimen, with the particular conditions to be measured as standards. However, only small sections of ruptured 1330 steel receivers were available for initial tests. No assurance was given that this steel represented the sole spurious material. It was not considered advisable to fabricate receivers made from 1330 material because of the problem urgency, the time and expense required to fabricate complete receivers, and the uncertainty as to materials which might be mixed. The approach taken was to examine as large a number of receivers as possible. Magnetic test methods employing Magnatest FS-300, Magnetic Analysis Production Comparator, and Magnatest ED-500 equipment were used. Tests were concentrated on receivers from the heat lot producing the ruptured receivers. The procedure involved the recording of the serial number of the receiver tested and the test reading obtained on each instrument. All readings, such as amplitude, phase, and wave form harmonic content were recorded. Receivers indicating different magnetic properties were then analyzed spectrographically. In January 1961, spectrographic results revealed that eight 1330 material receivers had been found.

3. PROCEDURE - continued

The procedure was then shifted to obtain additional test data to determine if material differences could be correlated with electromagnetic test results. Magnatest FS-300 and Magnetic Analysis Production Comparator equipment were used. Test readings were recorded and receivers were analyzed spectrographically. Frequency distribution curves were made of electromagnetic test readings obtained with the Magnetic Analysis Production Comparator equipment. Distribution studies revealed wide deviations in certain lots of receivers made from 8620 material. Metallurgical investigations of hardness and structure were conducted to determine the cause of the deviations. The range of acceptance for the test method employing Magnetic Analysis Production Comparator equipment was based on the results of these studies.

Various types of spot tests were suggested and some were tried as a possible means of effecting a separation. Most of the philosophy was based on the expected quantities of certain elements in the 8620 steel as compared to 1330 steel. The presence of residual alloy in the 1330 steel used, together with the possibility that other spurious material might be involved, made these methods unreliable. Watertown Arsenal proposed separation methods employing X-Ray Spectroscopy and neutron activation of Manganese.

4. ELECTROMAGNETIC TEST METHOD AND EQUIPMENT

Magnetic properties of receivers were compared in the method employed. Basically, effective permeability was compared. Lower permeability was indicated in the positive direction and higher permeability in the negative direction.

The measuring equipment contained a 60 c.p.s. generator, a pair of similar coils, an amplifier, filter and detector circuits for indicating the resultant coil output voltage. Each of the similar coil units contained a primary and secondary winding. The primary winding of each coil applies an a.c. magnetizing field to any sample placed within the coil. The secondary windings are connected in series opposition so that only the difference voltage between the two secondaries is measured by the indicator circuit. When like samples with identical magnetic properties are placed within the coils, the induced voltage in each secondary winding is equal, and the resultant output voltage is zero. In the actual test, a reference receiver was placed in one coil where it remained throughout the test. Receivers being compared were then inserted in the other coil and the reading noted.

5. RESULTS

The reported results cover work performed by several sections within Research and Materials Laboratories, Springfield Armory. Results are reported under various headings because of the complexity of the study.

a. Investigations on Fractured Receivers

Chemical and metallurgical data compiled on fractured receivers, "Code OH" 19478 and "Code HG" 73293, are shown in Tables 1 and 2. These receivers were found to be made from 1330 material. Damaged receivers and receiver fractures are pictured in Figures 1-4. A photomicrograph of the structure in "Code HG" receiver 73293 is shown in Figure 5.

TABLE 1

Chemical Data on Fractured Receivers

Element	Specification Requirement 8620H	"Code OH" 19478	"Code HG" 73293
Carbon	0.17 - 0.23	0.30 0.31	0.30 0.31
Manganese	0.60 - 0.95	1.79	1.81
Silicon	0.20 - 0.35	0.29	0.20
Sulfur	0.035 - 0.050		0.041
Phosphorous	.040 max.	0.054	0.054
Chromium	0.35 - 0.65	0.20	0.20
Nickel	0.35 - 0.75	0.14	0.14
Molybdenum	0.15 - 0.25		

5. RESULTS - Continued

TABLE 2

Metallurgical Data on Fractured Receivers

Receiver Number	Hardness Surface RB	Hardness Core RC	Depth of Case	Microstructure Free Ferrite	Upper Bainite	Martensite	Lower Bainite
Specified	61-69	31-42	.012-.018	10 max.			
"Code OH" 19478	68-69	51-53	.016-.020	<5	None	50	50
"Code HC" 73293	69-70	53-53.5	.016	<5	None	50	50

b. Electromagnetic Test Investigations

Test data were gathered at contractor plants employing Magnetic Analysis Production Comparator, Magnatest FS-300, and Magnatest ED-500 equipment. Tests conducted with the MA Production Comparator (noting amplitude, phase, and wave form harmonic content when using all frequency selection and high sensitivity) resulted in the discovery of 1330 material receivers. Data sheets recording receiver serial numbers, electromagnetic test readings, and spectrographic results on receivers are shown in Appendix A, Initial Screening Studies. Receivers made of 13XX material had high plus readings and wave form contained all third harmonic content with and without phase shifts on MA equipment. Receivers made of 86XX material showed for most part third and fifth harmonic contents with most readings less positive than noted with 13XX material receivers. A group of 86XX material receivers gave high plus readings on MA equipment but were shown to differ widely in phase on the Magnatest FS-300 equipment.

Results on initial screening studies indicated method feasibility but additional study was required to determine whether correlation actually existed between the test method and the material separation. Additional studies were also required to determine whether best possible frequency and test set up were being used. Test development studies were thus undertaken employing MA equipment. Appendix B shows data sheets on gathered information. Studies showed that a better separation was obtained employing 60 cycle rather than all frequency operation. Sensitivity was set to give high off-scale plus readings for 13XX material receivers. 86XX material receivers which in initial screening studies had given high plus readings comparable to the 13XX material now had readings no greater than +39. High nickel alloy material

3. RESULTS - Continued

gave -95 reading with a large phase shift. 86XX material showed negative readings as high as -100 off scale but with phase shifts not as great as with the high nickel material. Photographs of the equipment, meter readings, and scope patterns are shown in Figures 6 and 7.

During the investigation, tests were conducted on parkarized and unparkerized receivers. This condition did not change results noticeably. Both assembled and unassembled receivers were tested. Changes in readings were noted with barrels, rear sights, etc., attached. The degree of retained magnetism greatly affected test results. The greater the magnetism was, the more plus the reading. A field intensity meter was employed to check for magnetism before testing. Effects of retained austinite and temperature on receivers at test had little effect on results. Studies of effects of tempering and retempering receivers are reported in a following section.

c. Spectrographic Analyses

Assurance of a high confidence level in the material separation necessitated the spectrographic analyis of many more receivers after the test development studies. The whole lot of receivers containing spurious material was examined. Electromagnetic tests were first conducted and readings recorded. Then, each receiver in turn was analyzed spectrographically. Spectrographic results previously compiled and shown in Appendix B and the remainder of the lot, data listed in Appendix C, confirmed the correlation. Spectrographic results gave 100 per cent correlation with electromagnetic test results. A total of 543 were analyzed as 86XX series, 10 as 13XX series, and one as high nickel alloy. Previous magnetic tests resulted in an identical breakdown on the same receivers.

d. Distribution Studies

Data compiled on 554 "Code HG" receivers from Lot B were plotted to give a grequency distribution of electromagnetic test readings (Chart 1). Additional plots of frequency of readings on 100 Springfield Armory receivers and 180 "Code HG" receivers taken from delivered weapons and representing different heat lots, are shown in Charts 2 and 3.

Distribution on the 554 "Code HG" receivers from Lot B closely resembled that obtained on the 100 Springfield Armory receivers tested. Plots displayed a range of primarily -40 to +40 in readings. The distribution for "Code HG" receivers shifted

5. RESULTS - Continued

slightly negative and the Springfield Armory receivers shifted slightly positive. Wide deviation in distribution resulted on the 180 contractor receivers from various heat lots. Greater negative readings were predominant; a large percentage fell outside the -40 reading, particularly in Lots C and E.

c. Metallurgical Investigations

The cause of the wide deviation noted in the distribution study on the 180 "Code HG" receivers was investigated. Electromagnetic test readings were recorded on approximately 25 known 8620 material receivers which gave various negative readings. Metallurgical investigations comprising surface and core hardness measurements, structure examinations in various areas, and estimates of case depth were made. A receiver and sections from which direct core Rockwell C measurements were made are shown in Figure 8. Data on surface and core hardness measurements in the pictured areas are tabulated in Table 3. Microstructure and case depth estimates for three areas are shown in Tables 4-6. Additional hardness data, Rockwell A plus conversion to Rockwell C in these areas are also shown.

Caution must be exercised in the exact interpretation of the magnetic instrument reading. The instrument is not capable of determining the actual hardness in any specified area, e. g., the lug section. It averages the conditions prevalent in the material which is within the field of the coil. Metallurgical investigations indicate that as the test reading becomes more negative, hardness generally decreases. Significant information is obtained by comparing hardness in identical sections, such as area A, B, etc., because section sizes vary widely. In the receiver lug section (area G), test readings more negative that -40 generally show Rockwell C hardness below C30. The hardness specified for this area is Rockwell C 31-42. Hardnesses were obtained which were 10 to 15 points softer in other sections of these receivers.

Investigations revealed that material alterations were detected in the magnetic test. Metallurgical examination of receiver 71980 revealed localized tempering or annealing. A photomicrograph of an area within this receiver is shown in Figure 9.

5. RESULTS - Continued

f. Retempering Study

Test readings were greatly changed when receivers were retempered from their initial treatment. The results of this study are shown in Table 7.

On initial retempering at 400°F, electramagnetic test readings were changed 8 to 15 points in the negative direction; second retempering at 400°F changed readings 3 to 5 points further negative (see Table 7). On retempering at slightly higher temperature (425°F), readings were altered 8 to 12 points more in the negative direction. Readings changed radically to -off scale when retempered at 500°F. Two additional receivers were retempered directly at 500°F. Each gave readings of -off scale. This indicated that this tempering temperature was critical to the test reading. In the previous studies reported, negative readings beyond -40 had indicated generally softer receiver hardness or locally treated receivers. This investigation now indicates another possibility for high negative readings.

Receiver Test Results

Initial Screening Studies

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300		Spectrographic Analysis
	Amplitude	Phase and Harmonics	Amplitude	Phase	
71244	+100	All 3rd	4.0	45	13XX
71974	+100	All 3rd	3.8	35	13XX
69121	+100+	All 3rd	4.0	50	13XX
73761	+100	90° P.S All 3rd	3.8	40	13XX
71927	+100+	90° P.S. All 3rd	3.9	40	13XX
72929	+100+	90° P.S. All 3rd	3.8	40	13XX
74238	+100+	90° P.S. All 3rd	3.7	40	13XX
74486	+100+	90° P.S All 3rd	3.8	45	13XX
66979	+100+	90° P.S. Some 3rd, 5th	4.4	70	86XX
66117	+100+	90° P.S. Some 3rd, 5th	4.5	70	86XX
71944	+95	All 3rd	4.3	65	86XX
71918	+80	All 3rd	4.3	65	86XX
69289	+75	All 3rd	4.3	70	86XX
69777	+50	All 3rd	4.3	60	86XX
71364	0	All 5th	4.9	85	86XX
71384	+15	All 5th	4.8	80	86XX
73828	+15	All 5th	4.4	75	86XX
72461	+10	All 5th	4.7	80	86XX
74166	0	All 5th	4.7	80	86XX
66628	+5	All 5th	4.9	80	86XX
73077	-40	All 5th	5.2	80	86XX
73023	-10	All 5th	5.2	85	86XX
66457	-10	Strong, 5th No, 3rd	4.6	80	86XX
66486	-35	Strong, 5th Slight 3rd	4.3	80	86XX

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300		Spectrographic Analysis
	Amplitude	Phase and Harmonics	Amplitude	Phase	
70040	+25	Strong 5th	4.6	80	86XX
67565	-20	Strong 5th	5.2	85	86XX
67206	+80	Some 5th	5.2	90	86XX
67529	-40	Strong 5th	5.2	80	86XX
73186	-40	Strong 5th	5.2	80	86XX
73201	-40	Strong 5th	5.2	80	86XX
73146	-60	Strong 5th	5.5	85	86XX
73227	-55	Strong 5th	5.5	85	86XX
73003	-70	Strong 5th	5.2	90	86XX
73132	-70	Strong 5th	5.2	90	86XX
73187	-50	Strong 5th	5.2	85	86XX
73191	-35	Strong 5th	5.3	90	86XX
73121	-25	Strong 5th	5.2	85	86XX
70578	-90	Strong 5th	5.2	85	86XX
68785	+5	Some 5th	4.7	80	86XX
69240	0	Slight 5th	4.7	80	86XX
68171	-80	90° P.S. Slight 5th	4.0	80	86XX
68112	-90	90° P.S Some 5th	4.5	75	86XX
73041	-50	90° P.S. Strong 5th	5.3	85	86XX
66097	-60	90° P.S. Slight	5.2	85	86XX

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300		Spectrographic Analysis
	Amplitude	Phase and Harmonics	Amplitude	Phas.	
66877	-40	Small P.S. Slight 5th	5.8	90	86XX
64948	-90	90° P.S.	4.7	80	86XX
73252	-60	90° P.S.	4.5	75	86XX
67292	-60	90° P.S.	4.3	70	86XX
67512	-100	90° P.S.	4.5	80	86XX
73591	-90	90° P.S.	4.3	70	86XX
73319	Off Scale -100	90° P.S.	7.0	105	86XX
73334	Off Scale -100	90° P.S.	7.1	105	86XX
71408	Off Scale -100	No P.S. No 5th	2.8	107	Not 13XX or 86XX High Nickel
72037	0	All 3rd	5.2	90	86XX
70910	-40	All 3rd	5.7	100	86XX
67750	+5	All 3rd	5.2	90	86XX
69134	0	All 3rd	5.2	85	86XX
69327	-10	All 3rd	5.2	95	86XX
68746	-10	All 3rd	5.2	85	86XX
73208	-15	All 3rd	5.2	85	86XX
71150	-10	All 3rd	5.3	90	86XX
72895	-10	All 3rd	5.2	85	86XX
65871	-15	All 3rd	5.6	90	86XX
66515	-5	All 3rd	5.0	80	86XX
66923	-30	All 3rd	5.2	85	86XX

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300		Spectrographic Analysis
	Amplitude	Phase and Harmonics	Amplitude	Phase	
67280	-10	All 3rd	5.5	90	86XX
67430	+20	All 3rd	5.3	85	86XX
73765	-60	All 3rd	5.7	100	86XX
67569	-30	All 3rd	5.7	95	86XX
66145	-100	90° P.S. No 5th	4.9	80	86XX

APPENDIX B

Receiver Test Results

Test Development Studies

"Code HG" Receiver Identification	Magnetic Analysis Amplitude	Production Comparator Phase	Spectrographic Analysis
71244	+105		13XX
71974	Off Scale +100		13XX
69121	+95		13XX
73761	Off Scale +100		13XX
71927	Off Scale +100		13XX
72929	Off Scale +100		13XX
74238	Off Scale +100		13XX
74486	Off Scale +100		13XX
66979	+39	SPS	86XX
66117	+33	SPS	86XX
71944	+30		86XX
71918	+25		86XX
69289	+25		86XX
69777	+23		86XX
71364	-15		86XX
71384	+15	P.S.	86XX
73828	+5		86XX
72461	0		86XX
74166	0		86XX
66628	-8		86XX
73077	-25		86XX
73023	-14		86XX
66457	0	SPS	86XX
66486	0	SPS	86XX
70040	-2		86XX
67565	-22		86XX
67206	-11		86XX
67529	-27		86XX
73186	-20		86XX

"Code HG" Receiver Identification	Magnetic Analysis Amplitude	Production Comparator Phase	Spectrographic Analysis
73201	-20		86XX
73146	-46		86XX
73227	-48		86XX
72605	-40		86XX
73132	-38		86XX
73187	-35		86XX
73191	-32		86XX
73121	-27		86XX
70578	-50		86XX
68785	-13	SPS	86XX
69240	-12	SPS	86XX
68171	-12		86XX
67312	-22		86XX
73041	-33		86XX
66097	-30		86XX
66877	-55		86XX
64948	-10		86XX
73252	0		86XX
67292	+5		86XX
67512	-20		86XX
73591	0		86XX
73319	Off Scale -100		86XX
73334	Off Scale -105		86XX
71408	-100	Large P. S.	Not 13XX or 86XX High Nickel
72037	-30		86XX
70910	-56		86XX
67750	-16		86XX
69134	-25		86XX
69327	-35		86XX
68746	-25		86XX

"Code HG" Receiver Identification	Magnetic Analysis Amplitude	Production Comparator	Spectrographic Analysis
73208	-18		86XX
71150	-27		86XX
72895	-30		86XX
65871	-30		86XX
66515	-16		86XX
66923	-35		86XX
67280	-35		86XX
67430	-13		86XX
73765	-55		86XX
67569	-46		86XX
66145	-30		86XX

APPENDIX C

Receiver Test Results

Correlation Studies

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
70091	0	SPS	0	86XX
69963	0	SPS	0	86XX
70120	0	SPS	0	86XX
68788	-2	SPS	0	86XX
69570	-7	SPS	+1.5	86XX
72373	-2	SPS	+0.5	86XX
72774	0	SPS	0	86XX
69906	-5	SPS	+1.5	86XX
69995	-3	SPS	+1	86XX
69968	0	SPS	0	86XX
69923	-12	SPS	+2.5	86XX
70077	-5	SPS	+0.5	86XX
70076	-10	SPS	+1.5	86XX
70054	0	SPS	0	86XX
70093	+2	SPS	-1	86XX
69896	0		-1	86XX
69902	-8	SPS	+1.5	86XX
69924	-4		0	86XX
69727	+8	SPS	-2.5	86XX
69779	+12	SPS	-2.5	86XX
69785	+19	SPS	-3.5	86XX
69787	+2	SPS	-1	86XX
69793	+13	SPS	-3	86XX
69801	0	SPS	-1	86XX
69804	0	SPS	-1	86XX
69825	-6		+1	86XX
69114	-3		0	86XX
69773	+20	SPS	-3.5	86XX
72062	+1	SPS	-1	86XX

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
68453	-7	SPS	+1	86XX
68541	-9	SPS	+1.5	86XX
73848	+23	SPS	-3.5	86XX
71672	+26	SPS	-4	86XX
68079	+2	SPS	-1	86XX
69965	-5		+1.5	86XX
72013	+40	SPS	-5.5	86XX
73251	-4	SPS	0	86XX
74167	+40	SPS	-4.5	86XX
73088	-20		+3.5	86XX
71298	-6		+1.5	86XX
72790	-52	SPS	+7	86XX
71994	+39	SPS	-4.5	86XX
72468	-22		+4	86XX
69069	+20	SPS	-2.5	86XX
73084	Off Scale -100	SPS	Off Scale +	86XX
74493	+60		-6.5	86XX
69967	Off Scale -100	SPS	Off Scale +	86XX
67039	+45		-5	86XX
71984	Off Scale -100	SPS	Off Scale +	86XX
69154	-17	SPS	+2.5	86XX
72382	0	SPS	0	86XX
73031	-30	SPS	+4	86XX
67196	-10		+1.5	86XX
67906	-24	SPS	+3	86XX
68254	-2	SPS	0	86XX
67456	-5	SPS	+1	86XX
74031	+11	SPS	-2.5	86XX

"Code MC" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
67461	0	SPS	0	86XX
67241	-5	SPS	0	86XX
71167	-6	SPS	+1.5	86XX
67326	-23		+3.5	86XX
68069	-6	SPS	+1	86XX
67754	+2		-0.5	86XX
67970	-7	SPS	+1	86XX
68257	-17	SPS	+2	86XX
68233	-5	SPS	0	86XX
68360	+5	SPS	-1	86XX
66250	+4	SPS	-1.5	86XX
66642	-8	SPS	+1.5	86XX
66454	-15	SPS	+2.5	86XX
66666	0	SPS	-0.5	86XX
66495	+7	SPS	-1.5	86XX
68113	+4	SPS	-1.5	86XX
68220	-6		+1	86XX
67425	-11		+1.5	86XX
69339	-16		+2	86XX
65867	+2	SPS	-1	86XX
73797	0	SPS	-1	86XX
70490	+2	SPS	0	86XX
73612	+4	SPS	+1	86XX
68816	-2	SPS	+1	86XX
66070	-32		+4	86XX
68627	-10		+2.5	86XX
72994	-40	SPS	+6	86XX
71687	+15	SPS	-2.5	86XX

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
68625	-12	SPS	+2	86XX
72982	0		0	86XX
69969	-5	SPS	+1.5	86XX
71937	+7		-1.5	86XX
68952	-2	SPS	0	86XX
70707	-2	SPS	+1.5	86XX
70710	-5		+1	86XX
70646	-2		+0.5	86XX
70643	0		0	86XX
70634	-6	SPS	+1	86XX
70828	-6	SPS	+1	86XX
70807	-1	SPS	0	86XX
70793	-2	SPS	0	86XX
70689	-2		0	86XX
70783	+2	SPS	-1	86XX
70778	0	SPS	-1	86XX
70666	-2	SPS	0	86XX
70662	0		+0.5	86XX
70733	0	SPS	-0.5	86XX
70653	-12	SPS	+2	86XX
67884	+10	SPS	-2.5	86XX
67287	-2		0	86XX
67230	-3		+1	86XX
73209	-16		+3	86XX
70583	-2		+1	86XX
72974	0		0	86XX
71900	+3		0	86XX
71802	+30		-3.5	86XX
73948	+23	SPS	-4	86XX

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
73796	+3		-1	86XX
73347	+16		-2.5	86XX
68287	-2		+1	86XX
74359	+18	SPS	-3.5	86XX
73966	+2		-0.5	86XX
73538	-26		+4.5	86XX
68174	-2	SPS	+1	86XX
68376	-8	SPS	+2	86XX
67251	-10	SPS	+1.5	86XX
69416	+12	SPS	-2.5	86XX
67403	-2		+0.5	86XX
73768	-13		+2.5	86XX
70363	-5	SPS	+1.5	86XX
68225	-5		+1.5	86XX
68845	-2		+1	86XX
68846	-3		+1	86XX
69256	-2		+1.5	86XX
69270	-18	SPS	+3.5	86XX
69575	-2	SPS	+1.5	86XX
68261	0	SPS	0	86XX
67485	-7	SPS	+1.5	86XX
71848	+14		-2.5	86XX
70081	-1	SPS	0	86XX
71004	-9	SPS	+1	86XX
71309	-3		0	86XX
73644	0	SPS	0	86XX
74254	+5		-1	86XX
72673	-10		+1.5	86XX
71916	+30		-4	
67647	+4		-1	

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
70706	-14		+1.5	86XX
69828	0		-1	86XX
69829	-3		0	86XX
69842	-2		0	86XX
69861	-1		0	86XX
69866	-2		+1	86XX
71037	0	SPS	-0.5	86XX
68941	+2		-0.5	86XX
69182	0		0	86XX
66874	-13		+2.5	86XX
68700	0	SPS	0	86XX
68329	+1	SPS	-0.5	86XX
70069	-10	SPS	+1.5	86XX
65637	-2		+0.5	86XX
69537	-3	SPS	+0.5	86XX
69173	+3		-0.5	86XX
70800	-2		0	86XX
70587	-10	SPS	+1.5	86XX
69690	+2	SPS	-1	86XX
68205	+1	SPS	-0.5	86XX
68911	-2		0	86XX
70836	-1		0	86XX
70842	+2		-1	86XX
70847	0		0	86XX
70867	-12	SPS	+2	86XX
70869	-8	SPS	+1.5	86XX
70881	+4	SPS	-1.5	86XX
70896	-6	SPS	0	86XX
70898	+2	SPS	-1.5	86XX

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
70899	-4	SPS	0	86XX
70912	-7	SPS	+1	86XX
70932	-1		0	86XX
70936	+5	SPS	-1.5	86XX
71003	-4	SPS	0	86XX
71031	+1	SPS	-1	86XX
71025	+4	SPS	-1.5	86XX
74273	0	SPS	-1	86XX
66286	-4	SPS	0	86XX
72465	-30		+4	86XX
66247	+4		-1.5	86XX
65957	-30	SPS	+4	86XX
66463	+3	SPS	-1.5	86XX
66867	-12	SPS	+1.5	86XX
67213	-1		0	86XX
67142	-5	SPS	0	86XX
74244	-2	SPS	-1	86XX
70952	+7	SPS	-2	86XX
71921	+4	SPS	-1.5	86XX
74308	-2	SPS	0	86XX
73860	+2	SPS	-1.5	86XX
69380	-4	SPS	0	86XX
68732	-5		+1.5	86XX
69190	-5	SPS	+1.5	86XX
69230	-2	SPS	0	86XX
69282	+2	SPS	0	86XX
69296	+7	SPS	-1.5	86XX
69300	+2	SPS	0	86XX
69557	-9	SPS	+1	86XX
68706	-7		+1.5	86XX

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
68794	+2		0	86XX
68649	-18	SPS	+3	86XX
68834	0	SPS	-0.5	86XX
68910	-10	SPS	+2	86XX
68949	-5	SPS	+1	86XX
68979	-4	SPS	+1	86XX
69081	+6		-1	86XX
70892	-6	SPS	+1.5	86XX
70574	-2		+0.5	86XX
70883	+2	SPS	-1	86XX
70922	-2		+0.5	86XX
70927	-3		+0.5	86XX
70750	-5		+1.5	86XX
67479	-17	SPS	+3	86XX
70591	-5	SPS	+1.5	86XX
70066	-12	SPS	+2.5	86XX
70145	-11	SPS	+2.5	86XX
70295	-8	SPS	+2	86XX
72007	0	SPS	+0.5	86XX
68970	+2	SPS	+0.5	86XX
71161	+2	PS	0	86XX
70476	-12	SPS	+2.5	86XX
70613	-12	SPS	+2.5	86XX
70614	0		0	86XX
70620	-17	SPS	+3	86XX
70625	-10		+2	86XX
70632	-10	SPS	+2	86XX
70495	-8	SPS	+1.5	86XX
70470	-4		+1	86XX
70415	0	SPS	0	86XX

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
70411	-4	SPS	+1	86XX
70401	0	SPS	0	86XX
70399	-11	SPS	+2	86XX
70347	-13	SPS	+2.5	86XX
70570	-14	SPS	+2.5	86XX
70585	-5	SPS	+1.5	86XX
70599	-6	SPS	+1.5	86XX
71506	-6	SPS	+1.5	86XX
72010	+4		-0.5	86XX
71550	-10	SPS	+2	86XX
71864	+15	SPS	-2	86XX
71928	+9	SPS	-1.5	86XX
71042	+5	SPS	-1	86XX
71064	0	SPS	0	86XX
71075	+2		0	86XX
71337	-6		+1	86XX
71386	-10	SPS	+2	86XX
71437	-3	SPS	+1	86XX
71453	-5		+1.5	86XX
71486	0	SPS	0	86XX
71500	-7	SPS	+1.5	86XX
71504	0	SPS	0	86XX
73505	+3		0	86XX
69427	-15		+3.5	86XX
71235	Off Scale +100		-14	13XX
70575	-7		+2	86XX
68020	+10		-1	86XX
70698	+95		-10	13XX
74062	+5		0	86XX
68994	0		+1	86XX

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
73852	+15		-2	86XX
67617	0		+1	86XX
68383	-20	PS	+3	86XX
68679	-12		+2.5	86XX
74312	-12		+2.5	86XX
71180	+5		0	86XX
66762	-15		+3.5	86XX
68849	+2	SPS	-1	86XX
69890	-2	SPS	0	86XX
69605	+5	SPS	-1.5	86XX
69272	+4	SPS	-1.5	86XX
69571	0	SPS	-1	86XX
69321	0	SPS	-1	86XX
70966	+20		-3	86XX
70055	-10		+1.5	86XX
67008	+23		-3.5	86XX
70413	-7	SPS	0	86XX
67885	-10	SPS	+1	86XX
68907	-6	SPS	+1	86XX
68874	+2	SPS	-1.5	86XX
67362	11		+2	86XX
70420	-6	SPS	+1	86XX
72364	+3		-1	86XX
71583	+36		-4.5	86XX
74032	+30	SPS	-4.5	86XX
74492	+20		-3	86XX
72351	+16	SPS	-3.5	86XX
74182	-2		0	86XX
71361	+2		0	86XX

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
71887	-3		+1	86XX
72156	+8		-1.5	86XX
70110	-6		+1	86XX
67613	-7		+2.5	86XX
67854	-2		+1	86XX
72933	-33		+5	86XX
70039	+2		-1	86XX
68380	-26		+4	86XX
70529	-15	SPS	+2	86XX
70555	0		0	86XX
70316	0	SPS	0	86XX
70305	-2		0	86XX
70292	-3	SPS	0	86XX
70283	0		0	86XX
70261	-6		+1	86XX
70215	0		0	86XX
70161	-2	SPS	0	86XX
70196	-7	SPS	+1	86XX
70180	0	SPS	-1	86XX
70172	0	SPS	-1	86XX
70152	0		0	86XX
70135	-2		0	86XX
70137	0		0	86XX
69268	-24	SPS	+3.5	86XX
71606	+3	SPS	-1.5	86XX
69899	-13		+1.5	86XX
69606	-6		+1	86XX
66270	+22	SPS	-3.5	86XX
68944	-16		+2.5	86XX
68001	-22	SPS	+3	86XX
69986	-8	SPS	+1.5	86XX

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
71710	+11	SPS	-2.5	86XX
69322	-57	SPS	+7	86XX
69504	-20	SPS	+3	86XX
68780	-12	SPS	+2	86XX
67377	-2	SPS	0	86XX
71287	-6	SPS	+1	86XX
71586	+17	SPS	-3	86XX
69318	-4	SPS	+15	86XX
69028	-8	SPS	+2	86XX
69246	-2	SPS	+1	86XX
69320	+3	SPS	0	86XX
69030	0	SPS	0	86XX
69125	-3	SPS	+1	86XX
69131	-4		+1	86XX
68571	-5		+1	86XX
69316	-7	SPS	+1.5	86XX
67558	-18		+2.5	86XX
66809	+4	SPS	-2	86XX
66572	-10		+1.5	86XX
68543	0	SPS	0	86XX
68352	+2	SPS	1	86XX
67737	-6	SPS	+1.5	86XX
68638	-9	SPS	+1	86XX
69442	-3		0	86XX
69429	-8	SPS	+1	86XX
68043	-8	SPS	+1	86XX
71316	-5	SPS	+1	86XX
69452	0	SPS	0	86XX
66746	+9	SPS	-2	86XX

"Code HC" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
67112	+10	SPS	-2.5	86XX
66961	-16	SPS	+2	86XX
67183	-10	SPS	+1.5	86XX
68915	+5	SPS	-2	86XX
68572	-12	SPS	+2	86XX
68533	-2	SPS	0	86XX
67413	-2		0	86XX
68962	0	SPS	0	86XX
69505	-2		+1.5	86XX
69331	-33	SPS	+5	86XX
71988	+18		-2.5	86XX
73886	+25		-3	86XX
71654	+28	PS	-4	86XX
71034	+25	SPS	-2.5	86XX
73178	-25		+4.5	86XX
67707	+43	PS	-5.5	86XX
73009	+4		-1	86XX
73052	+3		0	86XX
69047	-32	SPS	5	86XX
71380	+2	SPS	0	86XX
74489	+20		-2.5	86XX
71718	+18		-2	86XX
73574	-3		+1.5	86XX
66871	-32	SPS	+4.5	86XX
70416	-32	SPS	+4	86XX
70087	-3	SPS	0	86XX
66340	+10	SPS	-1.5	86XX
73111	-35	SPS	+4.5	86XX
73952	+12	SPS	-2.5	86XX
73124	-36	SPS	+4.5	86XX

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
69507	-28	SPS	+3.5	86XX
68258	+2	SPS	-1	86XX
68252	-6		+1	86XX
67299	-2	SPS	-1	86XX
71970	+28	SPS	-4	86XX
71844	+20	SPS	-3.5	86XX
72397	+5	SPS	-1.5	86XX
73094	-12		+2	86XX
73660	-13	SPS	+1.5	86XX
73915	-8	SPS	+2	86XX
68861	-10	SPS	+1.5	86XX
72947	-39	SPS	+5	86XX
68223	-3	SPS	0	86XX
67451	-5		+1	86XX
66638	-11		+1	86XX
73743	-2	SPS	0	86XX
67262	-12	SPS	+2	86XX
69392	-36	PS	+4	86XX
69020	-18	SPS	+2.5	86XX
72682	-1		0	86XX
69467	-25	SPS	+3.5	86XX
67426	-8		+1.5	86XX
67788	-20	PS	+3	86XX
67278	-2	SPS	0	86XX
70664	-13		+2	86XX
71219	-15	SPS	+2	86XX
68815	+8	SPS	-1.5	86XX
68632	-5	SPS	0	86XX
70050	0	PS	-1	86XX

"Code HC" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
70787	-10	SPS	+1.5	86XX
69029	-3	SPS	0	86XX
70645	-13	SPS	+2	86XX
69314	+8	SPS	-2.5	86XX
69274	+4	SPS	-2	86XX
71310	-16	SPS	+2	86XX
69361	0	SPS	0	86XX
68825	0	SPS	0	86XX
67993	-7	SPS	+1	86XX
69478	0		0	86XX
71204	-15	SPS	+2	86XX
69692	+11	SPS	-2.5	86XX
68495	-6	SPS	+1	86XX
68497	-2		0	86XX
68524	-8	SPS	+1	86XX
68619	0	SPS	0	86XX
71441	-3	SPS	0	86XX
68530	+3	SPS	-1	86XX
68483	+2	SPS	-1	86XX
68415	+2	SPS	-1	86XX
70684	-10		+1.5	86XX
70897	+2	SPS	-1.5	86XX
71015	-6	SPS	+0.5	86XX
71211	-8	SPS	+1	86XX
68950	-3	SPS	0	86XX
69138	-3	SPS	0	86XX
69136	-2		0	86XX
69139	-6		+1	86XX
69140	+2		-1	86XX
72058	+16		-3	86XX
71549	0		-0.5	86XX

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
72043	+4		-1.5	86XX
72009	+9		-2.5	86XX
69024	-4	SPS	0	86XX
69005	+2	SPS	-1	86XX
69000	-1	SPS	0	86XX
69552	-5	SPS	+1	86XX
69455	-8	SPS	+1	86XX
69317	-12	SPS	+2	86XX
69275	-5	SPS	+1.5	86XX
69251	-30	SPS	+4.5	86XX
70014	-18	SPS	+2.5	86XX
73927	+2	SPS	-0.5	86XX
68479	-16	SPS	+2.5	86XX
69652	-37	SPS	+5.5	86XX
66549	-3		0	86XX
66656	-12		+2.5	86XX
66862	-18		+2.5	86XX
67918	0	SPS	0	86XX
67856	-11		+2	86XX
66948	+14	SPS	-2.5	86XX
66163	-3	SPS	+1	86XX
65870	+7		-1	86XX
66803	-6		+1.5	86XX
70303	-16	SPS	+2	86XX
70053	+10		-1.5	86XX
70112	-1	SPS	-1	86XX
70041	+1	SPS	-1	86XX
70061	-8	SPS	+1.5	86XX
69242	-2	SPS	0	86XX
68296	-5	SPS	+1	86XX
68715	-3		0	86XX
70716	-5	SPS	0	86XX
70686	-10		+1	86XX
67432	-8		+1.5	86XX

"Code HG" Receiver Identification	Magnetic Analysis Production Comparator		Magnatest FS-300	Spectrographic Analysis
	Amplitude	Phase	Amplitude	
69985	-5		0	86XX
69863	-5	SPS	+0.5	86XX
69818	0	SPS	-0.5	86XX
69999	-6	SPS	0	86XX
69484	-11	SPS	+1.5	86XX
69593	-3	SPS	0	86XX
69512	-2		0	86XX
67380	-24	SPS	+3.5	86XX

APPENDIX D

Charts 1 to 3

Tables 3 to 7

Figures 1 to 9

CHART 1 - DISTRIBUTION OF TEST READINGS ON [illegible] RECEIVERS FROM HEAT LOT B

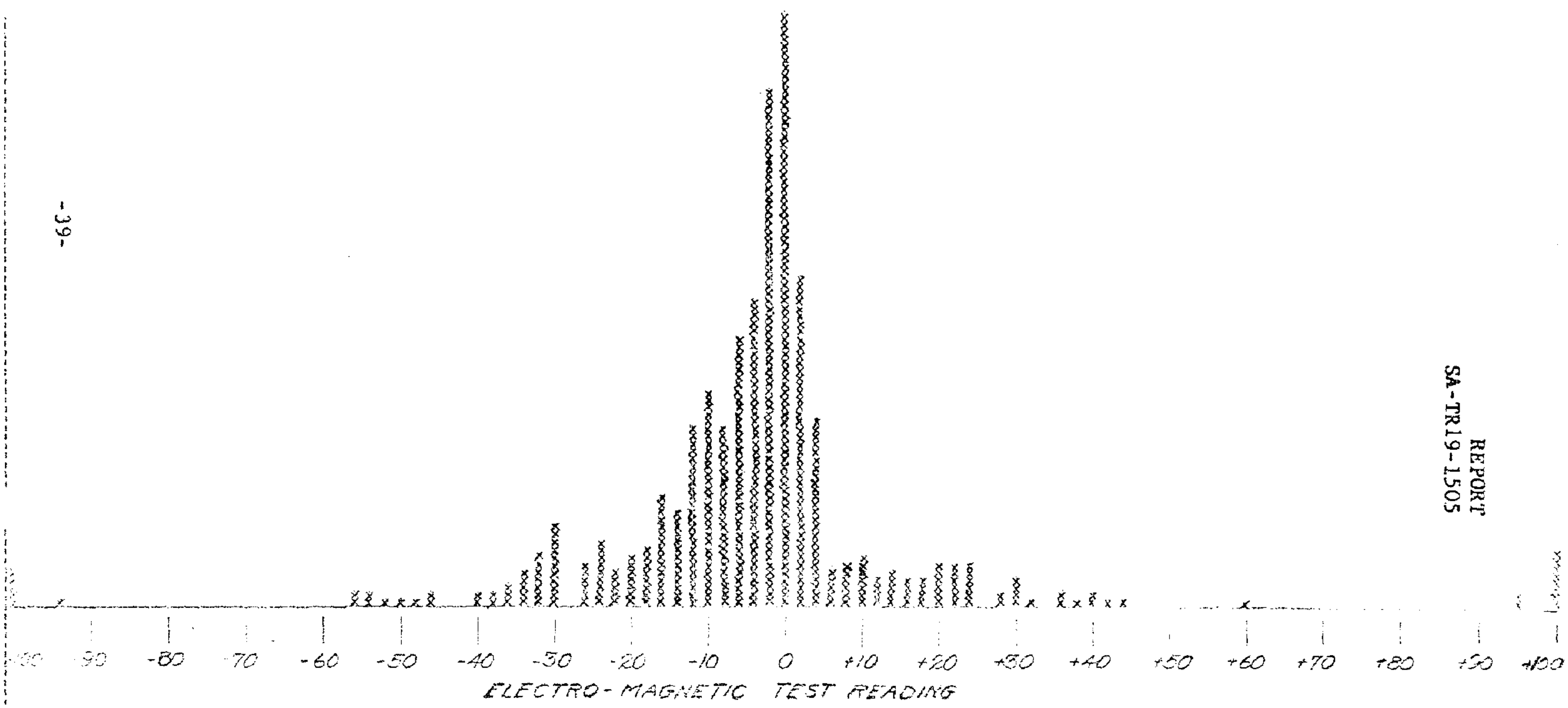


CHART 2 - DISTRIBUTION OF TEST READINGS ON 100 SA RECEIVERS

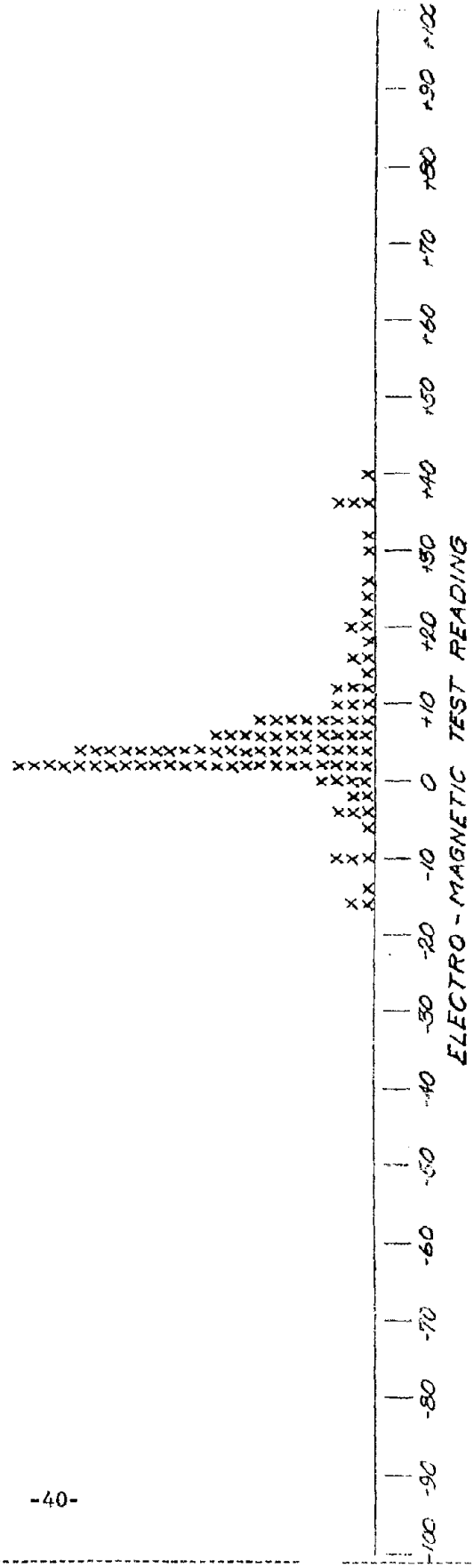


CHART 3 - DISTRIBUTION OF TEST READINGS ON 180 "CODE H6" RECEIVERS FROM VARIOUS LOTS

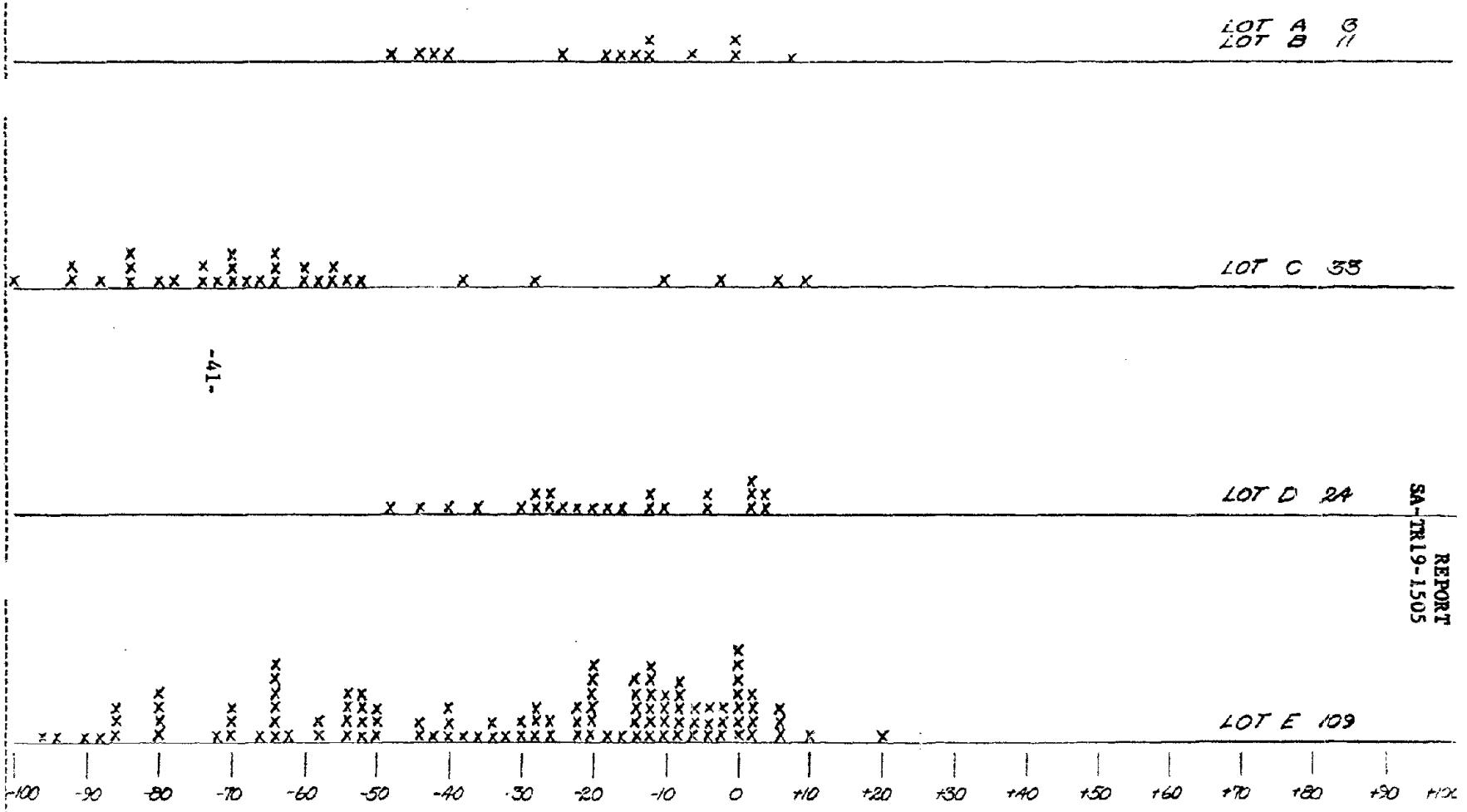


TABLE 3 – SURFACE AND CORE HARDNESS MEASUREMENT DATA

RECEIVER IDENTITY	MAGNETIC ANALYSIS READING	SURFACE		CORE HARDNESS OF SECTIONS									
		R_D	R_C	A	B	C	D	E	F	G	H	I	J
[illegible] 76244	−3	65-69	50-52.5	28.5-29	27-27.5	26.5	25.5	30-31	29.5-31.5	29.5-33.5	37-40.5	41-41.5	35.5-37.5
" 79209	−5	66-68	52-54	33.5-34.5	31	29-29.5	31.5	39-39.5	38-39	33.5	40.5-42.5	41.5-43.5	40-43
" 76041	−12	66-68	52-54	34.5-36	34.5-35	31.5-32.5	34-34.5	38-38.5	37.5-38	40.5-43	42-43	44.5	43.5-44.5
" 69529	−25	67-68	54-55	37.5-39.5	38.5-40.5	36-36.5	36.5	39-39.5	37.5	42.5-44.5	44-44.5	45.5	45-46.5
" 77068	−35			30-31.5	28-30.5	29-29.5	28-30.5	36.5-37.5	37-37.5	36.5-37	38.5-39	42.5-43.5	43.5-45.5
" 73198	−35			31.5-32	28.5-29.5	29.5-30	34-34.5	41.5-43.5	36.5	33-34.5	42-44	43-45.5	45.5-46
" 67735	−40			28.5-29.5	27.5-28	25.5-26.5	28-31	31.5-34	24.5-25.5	31-32.5	37.5-38.5	41.5	40.5-41
" 80162	−40			27-28	25.5-26	23-24.5	27-27.5	30-33	30-31	28.5-30.5	36-43	41.5-43	37-38.5
" 77128	−45			31.5-32.5	27.5-29	28.5	27.5-30	31-33.5	33-35	35.5-36.5	38.5-39	42.5	42-43
" 77695	−60			24-24.5	20.5-23.5	22.5	24.5-25	24-26	27-28	25-25.5	26-31.5	31-33.5	30.5
" 78336	−50			23-24.5	23-25.5	25.5-24.5	24-26	25-25.5	27.5-28.5	28.5-29	34-38	34-35.5	35-37
" 79132	−50			22.5-24.5	22-23.5	21.5-22	25	28-29	26-27.5	24-25.5	32-36.5	30-33.5	29-30.5
" 79258	−50			25-26	23-24.5	23.5-24	24-26	26-26.5	28-30.5	26.5-28	28-32	32-34	33-35
" 79972	−50	64-65	48.5-49.5	23-24	21.5-23.5	23.5	24.5-25.5	26.5-28	26.5-27.5	28-29	33-35	33.5-34.5	30-31
" 71380	−55	65.5-68	51-52	23-25	22.5-23.5	21.5-22.5	26	26-28	23.5-30.5	24-24.5	33-34	33.5-34.5	34.5-35.5
" 81497	−55			23.5-25	23-24.5	24-25	25.5-26.5	26.5-28.5	27-28	26.5-27	29.5-34	31-32.5	31.5-32
" 76336	−55			23-24.5	23-25.5	23.5-24	24-26	25-25.5	27.5-28	28.5-29	34-36	34-35.5	35-37
" 76335	−55			21.5-23	16.5-20.5	19-24	23-23.5	25-27	24.5-25	24.5-26	32-36.5	34-35	35-37
" 50295	−55	63-65	49-51	24	22-23	21-22.5	22-24	24.5-27	24-26	22.5-25.5	27.5-31.5	33-34	34.5
" 76716	−75	59.5-62	44.5-46	21.5-24	18.5-20	18-18.5	21.5-23.5	24.5-25	18.5-24.5	20.5	26-35	29.5-31	29.5-30.5
" 76940	−85	63-65.5	46.5-48.5	20.5-23.5	21-23	22	24	25.5-27.5	25-25.5	24-25.5	26-28.5	28.5-32	35.5-37
" 78799	−90	61.5-62.5	47.5-47.5	22.5-24.5	20.5-23.5	20.5-22.5	23-23.5	25-29	23.5-25.5	25-26.5	27.5-30.5	29-32	29.5-31
" 73345	−100	59.5-63	42.5-46	25	20.5-25	23.5-25	26.5-27.5	26.5-27.5	15-18.5	23-25.5	31.5-32	31-32.5	26.5-28.5

TABLE 4
STRUCTURE DATA – RECEIVER RING SECTION

RECEIVER IDENTITY	MAGNETIC ANALYSIS READING	HARDNESS			MICROSTRUCTURE			CASE	
		R_A	R_C (CONV)	R_C (DIRECT)	FREE FERRITE	UPPER BAINITE	MARTENSITE AND LOWER BAINITE	DEPTH (INCHES)	RETAINED AUSTENITE
"CODE HG" #76344	-3	64-65	27-29	27.5-28	5-10%	40-65% COARSE	REM.	.011-.013	100% TO .001"-.005"
" #79209	-8	66.5-67	32-33	33-35.5	5-10%	40-60%	"	.012-.014	100% TO .001"-.0015"
" #78041	-12	66-68	34-35	34.5-36	0-5%	25-35%	"	.011-.013	100% TO .0015"-.002"
" #69529	-25			35-38	5-10%	35-55%	"	.009-.013	100% TO .0005"-.001" 45-25% TO .003"
" #79972	-50			24.5	5-10%	50-80% VERY COARSE	"	.012-.014	100% TO .001"
" #71980	-55	63.5	26	26-27.5	5-10%	45-70% VERY COARSE	"	.012-.014	100% SUPERFICAL 40-25% TO .003"
" #80295	-65	63	25	24-25.5	5-10%	50-80% VERY COARSE	"	.012-.015	100% TO .001"
" #76716	-75			24-26.5	10-20%	35-70%	"	.009-.013	100% TO .0005"-.0015"
" #76940	-85			24-25.5	5-10%	55-85% COARSE	"	.008-.010	100% TO .0005"
" #78799	-90	62-63	23-25	24.5-25	5-10%	40-75% VERY COARSE	"	.013-.014	100% SUPERFICAL 25-10% TO .003"
" #75345	-100	64-65.5	27-29	26.5-28	35-45%	TRACES	"	.016-.017	100% TO .004"

TABLE 5
STRUCTURE DATA – RECEIVER LUG SECTION

RECEIVER IDENTITY	MAGNETIC ANALYSIS READING	HARDNESS			MICROSTRUCTURE			CASE	
		R_A	R_C (CONV)	R_C (DIRECT)	FREE FERRITE	UPPER BAINITE	MARTENSITE AND LOWER BAINITE	DEPTH (INCHES)	RETAINED AUSTENITE
CODE HS #76344	-3	65.5-67.5	30-34	30-34	5-10%	40-70% VERY COARSE	REM.	.013-.014	100% TO .001"
" #79209	-8			38-42	3-7%	10-25%	"	.014-.015	40-25% TO .003"
" #78041	-12	69.5-70	38-39	35-40	3-7%	15-30%	"	.012-.014	70-25% TO .004"
" #69529	-25	68.5-69.5	36-38	39.5	3-7%	5-20%	"	.012-.014	70-0% TO .004"
" #79972	-50	64-64.5	27-28	26.5-28	0-10%	50-80% COARSE	"	.014-.017	100% TO .001"
" #71980	-55			{18-22} {34-35}	3 ZONES 5-50%	70-80% VERY COARSE	"	.014-.015	25% - TRACE TO .002"
" #80295	-65	63	25	26.5	5-10%	40-75%	"	.017-.019	100% TO .001"
" #76716	-75	63-65	24-29	24.5-26.5	3-7%	60-80% VERY COARSE	"	.009-.011	20-0% TO .004"
" #76940	-85			26	10%	60-80% 1/2 COARSE	"	.009-.010	100% SUPERFICAL 20-15% TO .002"
" #78799	-90	62-63	23-25	24.5-25	5-10%	40-75% VERY COARSE	"	.013-.014	100% SUPERFICAL 25-10 TO .003"
" #73345	-100			{31-37} {18}	— 40-55%				

TABLE 6

STRUCTURE DATA - RECEIVER RAIL SECTION

RECEIVER IDENTITY	MAGNETIC ANALYSIS READING	HARDNESS			MICROSTRUCTURE			CASE	
		R_A	R_c (CONV)	R_c (DIRECT)	FREE FERRITE	UPPER BAINITE	MARTENSITE AND LOWER BAINITE	DEPTH (INCHES)	RETAINED AUSTENITE
"CODE HG" # 76344	-5				0-5	5-10%	REM.		55-35% TO .006"
" #79209	-8				0	TRACE	"		55-45% TO .006"
" #78041	-12				0	TRACE	"		45-35% TO .007"
" #69529	-25				0	TRACE	"		55-40% TO .005"
" #79972	-50				5-10%	35-45%	"		55-25% TO .004"
" #71980	-55				0-5%	10-15%	"		35-25% TO .005"
" #80295	-65				0-5%	35-45%	"		30-20% TO .005"
" #76716	-75				0-5%	35-45%	"		30-20% TO .005"
" #76940	-85				0-5%	20-30%	"		25-15% TO .003"
" #78799	-90				5-10%	20-30%	"		30-20% TO .003
" #73345	-100				45-55%	-REMAINER ———			70-60% TO .002"

Table 7

Retempering Study

Receiver Identification	Condition	Treatment	Electromagnetic Test Reading
"Code HG" 66117	Unparkerized		+30
		Retemper 1 hr @ 400°F	+15
		Retemper 1 hr @ 400°F	+10
		Retemper 1 hr @ 425°F	- 2
		Retemper 1 hr @ 500°F	-105
SA 99987	Parkerized		- 8
		Retemper 1 hr @ 400°F	-16
		Retemper 1 hr @ 400°F	-19
		Retemper 1 hr @ 425°F	-28
		Retemper 1 hr @ 500°F	- Off scale
"Code HG" 69995	Parkerized		- 7
		Retemper 1 hr @ 500°F	- Off scale
"Code HG" 70093	Parkerized		+ 2
		Retemper 1 hr @ 500°F	- Off scale

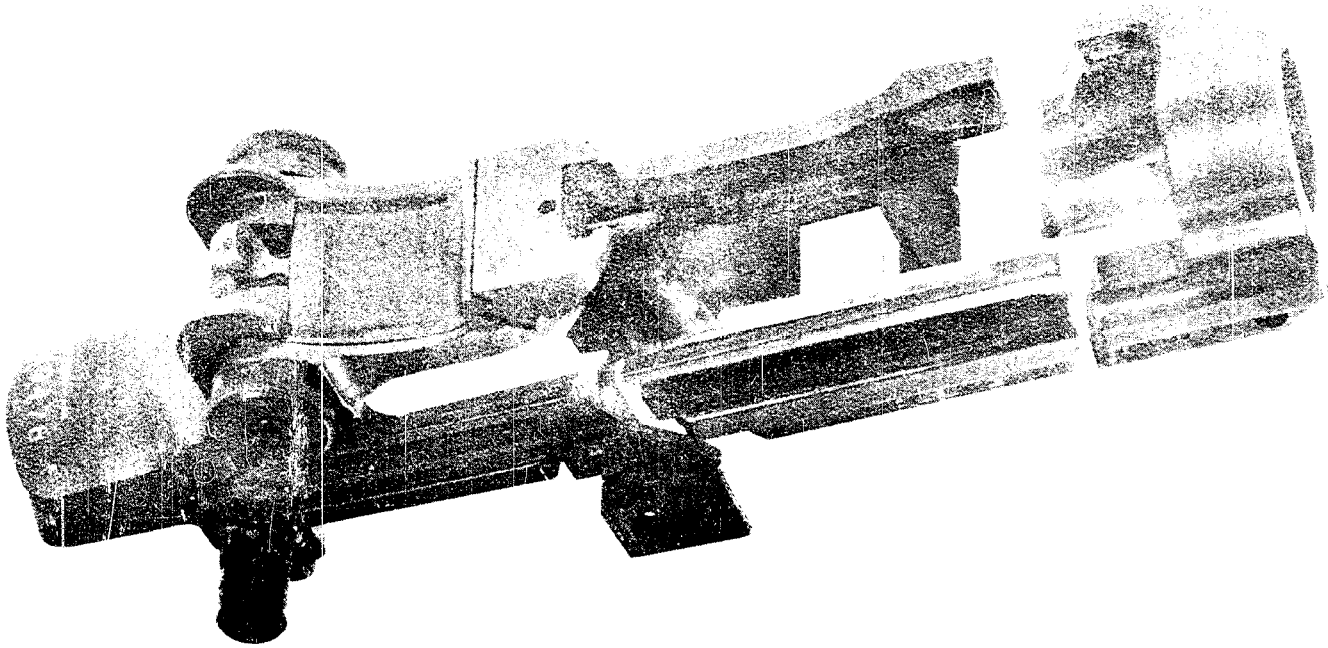


FIGURE 1

SPRINGFIELD ARMORY - ORDNANCE CORPS

Neg: 19-058-1397/ORD-60 Date: 15 Dec 1960 Proj:

RIFLE, 7.62-MM, M14 - "Code WH" #19478

DAMAGED RECEIVER

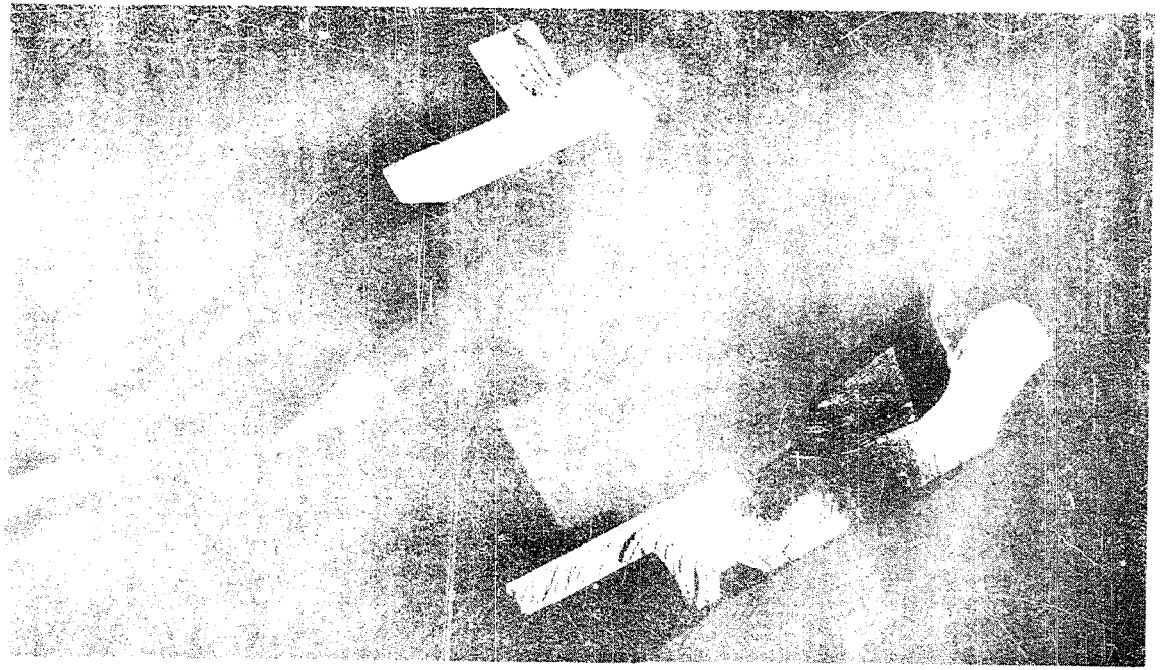


FIGURE 2

SPRINGFIELD ARMORY - ORDNANCE CORPS

Neg: 19-058-13?6/ORD-60 Date: 15 Dec 1960 Proj:

RIFLE, 7.62 [illegible] M14 - "Code WH" #19478

[illegible]EIVER

[illegible] Structure Sections

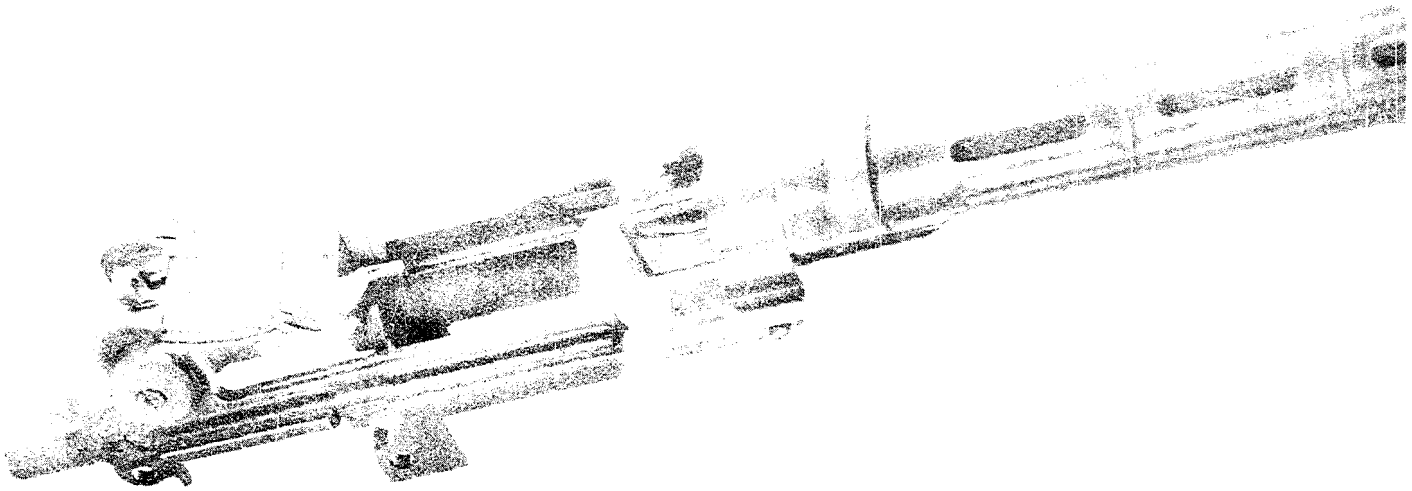


FIGURE 3

SPRINGFIELD ARMORY - ORDNANCE CORPS

Neg: 19-058-1386/ORD-60 Date: 20 Dec 1960 Proj:

RIFLE, 7.62-MM, M14 - "Code HG" #73293

DAMAGED RECEIVER

After Firing One Proof Round

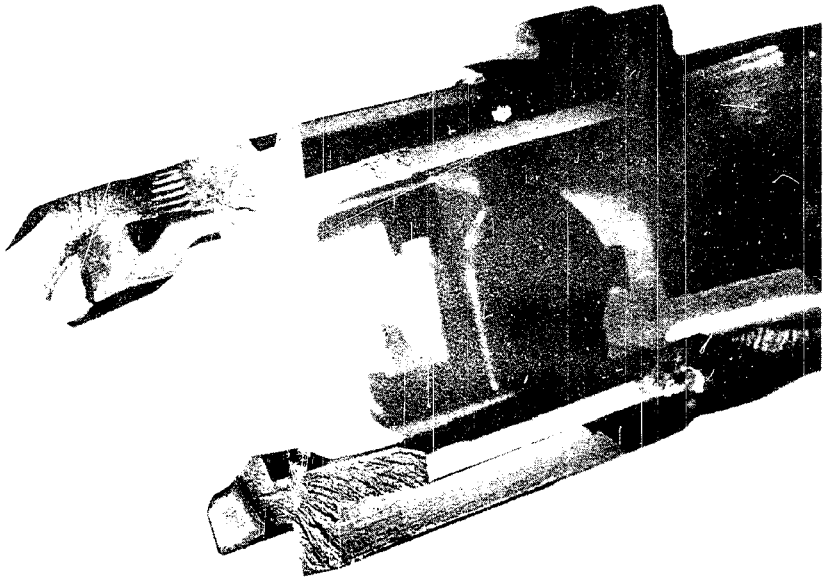


FIGURE 4

SPRINGFIELD ARMORY - ORDNANCE CORPS

Neg: 19-058-1388/ORD-60 Date: 20 Dec 1960 Proj:

RIFLE, 7.62-MM, M14 - "Code HG" #73293

RECEIVER FRACTURE

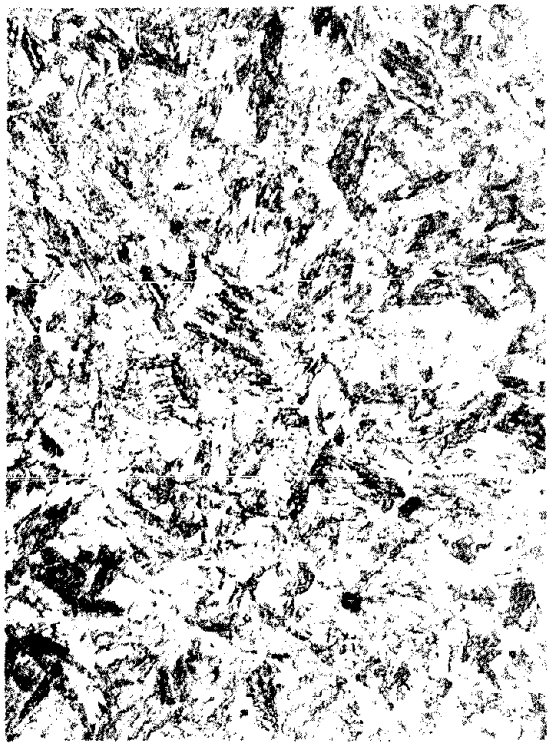
After Firing One Proof Round

FIGURE 5 - PHOTOMICROGRAPH - STRUCTURE "CODE HG" RECEIVER 73293

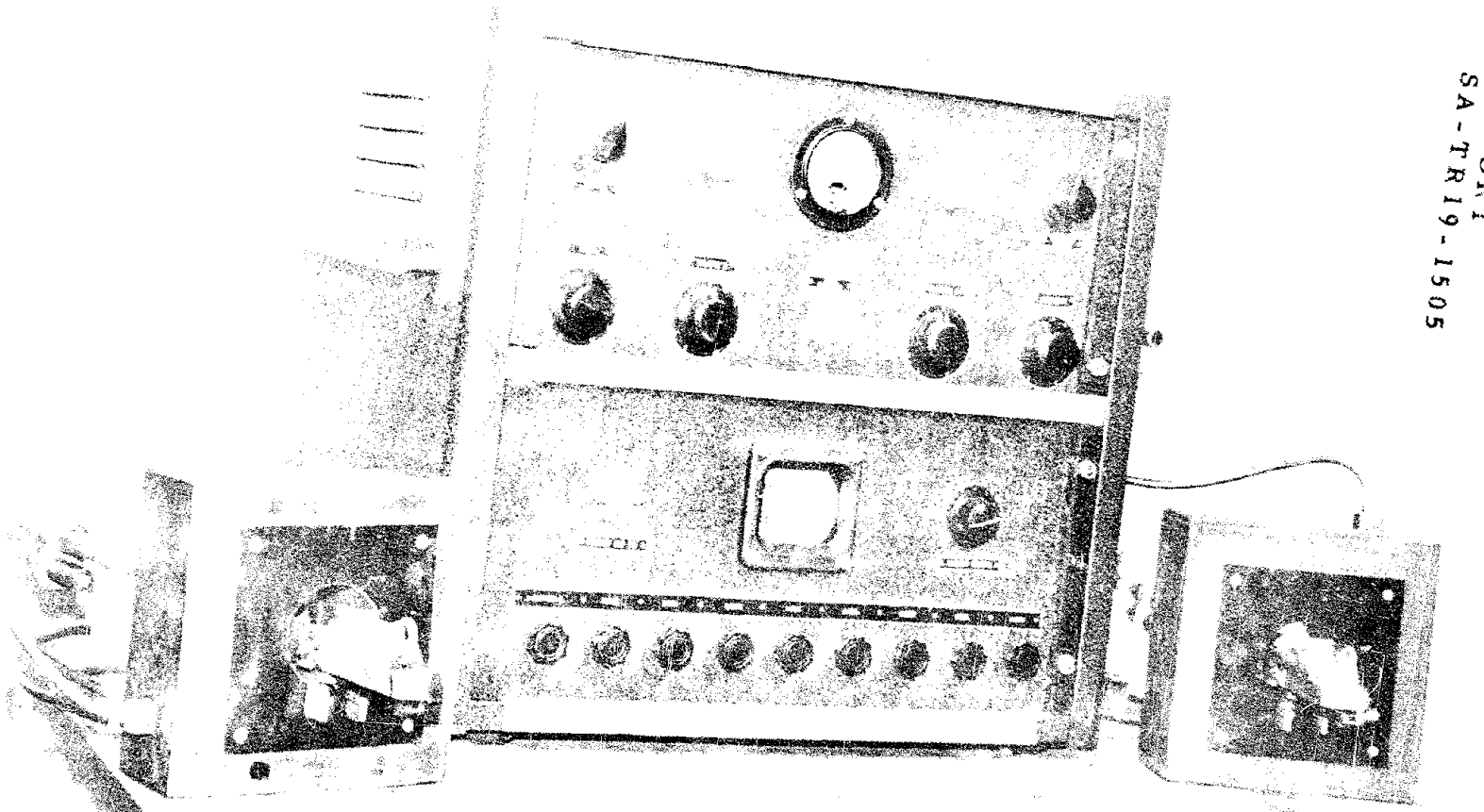
CASE

ETCHANT: NITAL

CORE



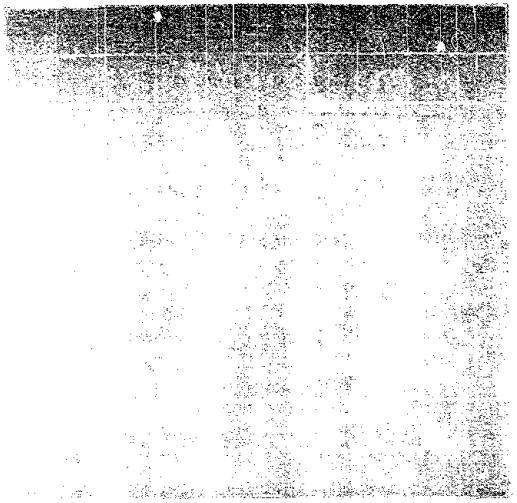
MAG.: 1000 X



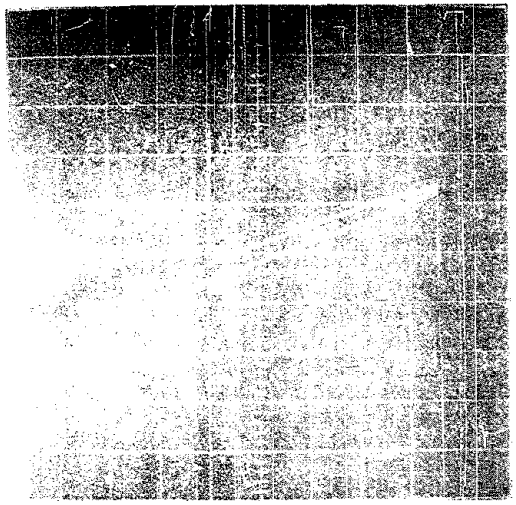
MAGNETIC ANALYSIS PRODUCTION COMPARATOR
TEST EQUIPMENT
FIGURE 6

FIGURE 7 - EQUIPMENT METER READINGS AND SCOPE PATTERNS

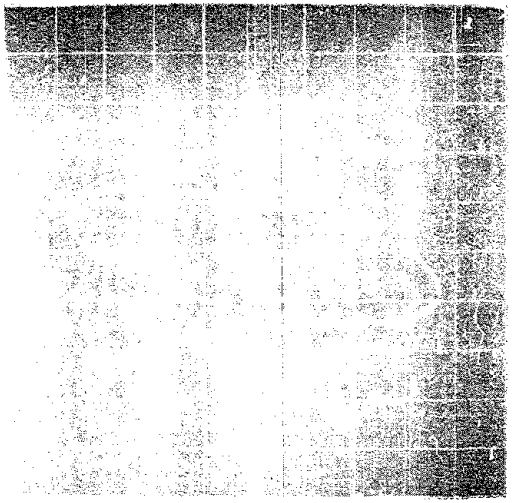
8620 H MATERIAL RECEIVER



1330 MATERIAL RECEIVER



HIGH NICKEL MATERIAL RECEIVER



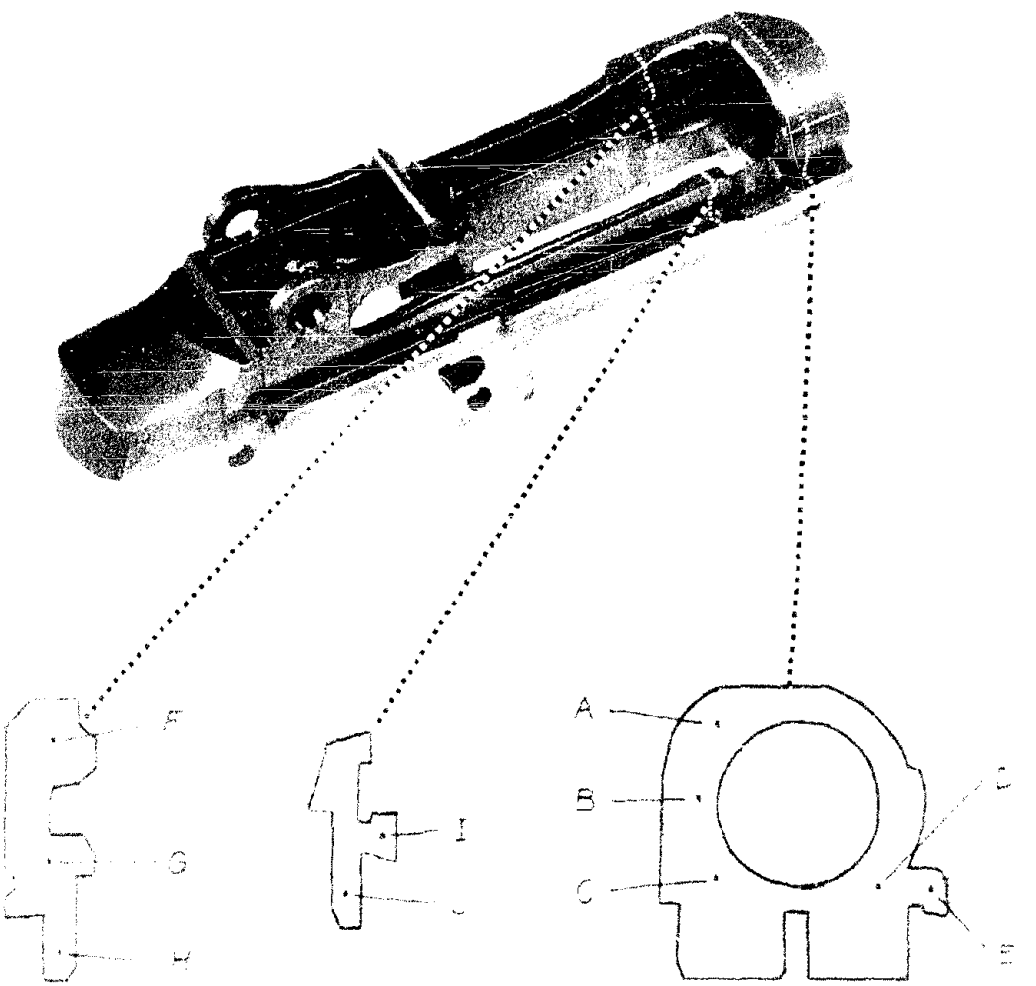
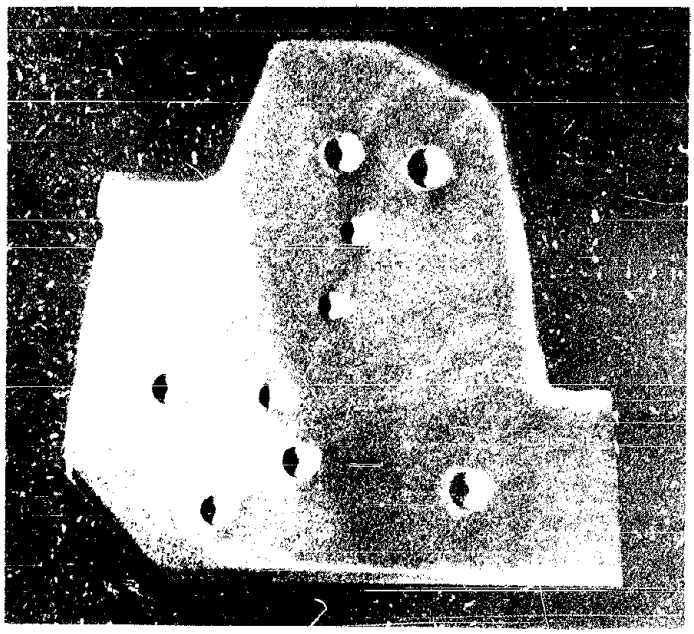

A
B
C
D
E
F
G
H
I
J

FIGURE 9 - MACROGRAPH SHOWING LOCALLY ANNEALED SECTION

IN "CODE HG" RECEIVER NO. 71980



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